Progress Report: ONR Award N00149710589 "Heuristic Approaches to Optimization with Applications"

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1 Results

This progress report covers the twelve months of funding on this grant since my previous progress report (August 1999). This grant covers two distinct lines of work: (1) the development of algorithms and implementations of heuristic search with applications, and (2) theoretical research on combinatorial algorithms and optimization. As detailed below, substantial progress has been made in both areas since my last progress report.

The renewal grant began on January 1, 2000. This grant is supporting four PhD students starting September 1, meeting the scheduled expenditure for this fiscal year. Our work has proven interesting to a large number of Navy personnel, as documented by the WWW hits below.

2 Environments for Combinatorial Computing

We have made progress this year on several projects related to combinatorial computing:

- *Enhancements to Combinatorica* – We [1] have made substantial progress on our effort to build an improved version of our combinatorial computing environment *Combinatorica*. Our primary goals are improved algorithmic performance and a better user interface. We have completed an alpha-release of the software, as well as documentation of the new features; all available at http://www.cs.sunysb.edu/~skiena/combinatorica. This site also includes representative graphics produced by the system.

  The new *Combinatorica* makes effective use of a new sparse-graph data structure [8], and is now capable of solving interesting problems on thousands or even hundreds of thousands of vertices, as opposed to the previous limit of about 100 vertices. The new system supports arbitrary edge/vertex colors, labels, and shapes; enhancing its

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ability to visualize graphical content and structure. Finally, we have provided powerful new algorithms for set partitions, Polya's theorem, and graphical enumeration. We are now building on this foundation to provide the generic support for combinatorial search promised in our proposal.

- *The Stony Brook Algorithm Repository* – Our collection of implementations of combinatorial algorithms [4] available on the WWW at http://www.cs.sunysb.edu/~algorith, continues to be an important resource for a lot of people. There has been a dramatic increase in the number of military sites accessing the algorithm repository, with 819 military sites this year as opposed to 313 a year ago! The site now receives well over one million hits per year! A list of all presumed Navy sites[1] has been appended to this progress report.

  This increase in interest is largely due to the efforts we made in upgrading the repository to make it more valuable to its users.

- *Combinatorial Dominance Guarantees for Heuristics* – The traditional theoretical measure of heuristic performance is approximation ratio, the guaranteed worst case gap between the optimal solution and one returned by this heuristic. However, the search-based local-improvement algorithms championed by our proposal offer very weak performance guarantees, even though they typically out-perform heuristics with superior approximation ratios.

  We [13] have recently developed an alternate theoretical measure of the quality of a heuristic, namely its *combinatorial dominance guarantee*. Such a guarantee measures the number of candidate solutions provably inferior to that returned by the heuristic. The better the heuristic, the more solutions it must dominate. An interesting example of the power of this measure compares the 2-opt versus the minimum spanning tree heuristics for TSP. Two-opt offers no theoretical guarantee, while minimum spanning tree yields a factor-2 approximation. However, we have shown that the minimum spanning tree heuristic can produce the *worst* of all the $(n-1)!$ tours, while the 2-opt solution always dominates an exponential number of tours. These results are in accord with the experimental results that 2-opt beats MST in practice.

  We have obtained similar results in our analysis of heuristics for such problems as vertex cover and the knapsack problem, and we are working on the outlines of a general theory.

- *PGMT Scheduling* – One of the primary applications of our combinatorial optimization engine will be improved PGMT scheduling of parallel processors, in collaboration with the Naval Research Laboratories We have recently obtained sample PGMT data from Dr. Ali Borujerdi of NRL and begun working with it.

3 Graph and Combinatorial Algorithms

We have also worked on a variety of other theoretical and applied problems in graph, string, and geometric algorithms:

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[1]Meaning all military sites not apparently associated with the Army, Air Force, or Marines.

- *Sheet Metal Assembly Problems* – We [5, 7] have studied the algorithmic complexity of certain geometric problems which arise in assembling structures from sheet metal and wires. In [5], we solved a long-standing open problem on the hardness of constructing an assembly sequence for a sheet structure from prescribed set of folds. In [7], we prove similar hardness results for building wire structures satisfying the physical requirement of non-crossing structures. We also provide efficient algorithms for interesting special cases.

- *Shift Error Detection in Standardized Exams* – We [3] have developed pattern recognition algorithms designed to identify shift errors in noisy sequences, with a particular application of identifying miss-marking errors on multiple choice, standardized examinations. Based on our analysis of over 100,000 SAT exams, we now have very convincing evidence that more than 2% of all students suffer from such errors on their SAT exams. Fortunately, our algorithms can help assign these students the grades that they deserve. We are now presenting our findings to the standardized testing community in the expectation that our algorithms be incorporated into their standard grading procedures.

  We have also written a short book on mathematical modeling [9] based on our experiences with such projects.

- *Back-translation Problems in Biology* – Genes are DNA sequences which code for proteins. Due to redundancy in the triplet code, any protein of given length can be coded for in an exponential number of distinct ways. In [10], we propose to exploit this redundancy by designing genes whose intermediate RNA has the maximum amount of structure. This idea of designing biological structures has some relevance to nanotechnology, and our techniques of using dynamic programming to construct an optimal structure are of independent algorithmic interest.

- *Geometric Separability Problems* – Certain geometric clustering / pattern recognition algorithms work by partitioning the space into regions of similarly colored or labeled examples, seeking the simplest such decomposition. We [11, 12] have developed efficient algorithms for wedge separability in the plane, which we proved optimal by showing a matching lower bound even in a restricted case.

As to the impact on education human and resources, in this period of ONR funding I have advised four Ph.D students (Barry Cohen, Vinhthuy Phan, Pavel Sumazin, and Vladimir Filklov), who are in various stages of their doctoral work (second through fourth years). Three of these (Barry Cohen, Vinhthuy Phan, and Pavel Sumazin) are American citizens or permanent residents.

Among other accomplishments, I served on the Program committee for *Workshop on Algorithm Engineering* (WAE 2000), Saarbruecken, Germany, September 2000. and continued to serve as Associate Editor for the *ACM Journal of Experimental Algorithmics*.

A list of recent publications by the PI acknowledging ONR grant support follows. These papers are available on-line at http://www.cs.sunysb.edu/~skiena/papers.html.

References

[1] S. Skiena and S. Pemmaraju, *Computational Discrete Mathematics: Combinatorics and Graph Theory with Mathematica*, Cambridge University Press, 2001

[2] J. El-Sana, F. Evans, A. Varshney, S. Skiena, and E. Azanli, Efficiently Computing and Updating Triangle Strips *Computer-Aided Design*, special issue on Multiresolution Geometric Models, 2000

[3] S. Skiena and P. Sumazin, Shift Error Detection in Standardized Exams, *Combinatorical Pattern Matching (CPM '00)* Montreal, CA, June 2000.

[4] S. Skiena, *The Algorithm Design Manual*, Telos/Springer-Verlag, New York, 1998.

[5] E. Arkin, M. Bender, E. Demaine, M. Demaine, J. Mitchell, S. Sethia, and S. Skiena, Recognizing Unfoldings of Simple Origami, submitted to *ACM-SIAM Symp. on Discrete Algorithms* (SODA 2001), January 2001.

[6] M. Bender, G. Pemmasani, S. Skiena and P. Sumazin, Least Common Ancestors on Directed Acyclic Graphs, submitted to *ACM-SIAM Symp. on Discrete Algorithms* (SODA 2001), January 2001.

[7] E. Arkin, S. Fekete, J. Mitchell, and S. Skiena, On the Manufacturability of Paperclips and Sheet Metal Structures, Submitted to *ACM-SIAM Symp. on Discrete Algorithms* (SODA 2001), January 2001.

[8] S. Skiena and J. Trias, A new graph data structure for *Combinatorica*, Technical Report MAII-IR-99-0032, Universitat Politechica de Catalunya, Barcelona Spain, December 1999.

[9] S. Skiena, *Mathematical Modeling to Win*, Cambridge University Press, New York, 2001.

[10] B. Cohen and S. Skiena, Optimizing RNA Secondary Structure over All Possible Encodings of a Given Protein in *Currents in Computational Biology*, ed. S. Miyano, R. Shamir, and T. Takagi, Universal Academy Press, 2000.

[11] E. Arkin, F. Hurtado, J. Mitchell, C. Seara, and S. Skiena, Some Separability Problems in the Plane *16th European Workshop on Computational Geometry*, Eliat, Israel, March 13-15, 2000.

[12] E. Arkin, F. Hurtado, J.S.B. Mitchell, C. Seara, and S. Skiena, Some Lower Bounds on Geometric Separability Problems, *Jornadas de Matematica discreta y algoritmica*, Mallorca, Spain, September 11-12, 2000.

[13] S. Skiena, Combinatorial Dominance Guarantees for Heuristic Algorithms, manuscript in preparation.

Appendix: Recent Navy WWW hits on the SB Algorithm Repository

Date	Navy Site	Date	Navy Site
02/Aug/1999	gw1.navspace.navy.mil	02/Aug/1999	luey.nawcad.navy.mil
04/Aug/1999	theodosius.cs.nps.navy.mil	09/Aug/1999	ppp1-37.nadn.navy.mil
10/Aug/1999	luey.nawcad.navy.mil	11/Aug/1999	herman.cmf.nrl.navy.mil
13/Aug/1999	server.wing11.nadjx.navy.mil	16/Aug/1999	burns.cmf.nrl.navy.mil
19/Aug/1999	luey.nawcad.navy.mil	23/Aug/1999	mercury.nrlssc.navy.mil
23/Aug/1999	romulus.metnet.navy.mil	25/Aug/1999	kbb06.cmar.navy.mil
25/Aug/1999	m071585.lrc.nps.navy.mil	26/Aug/1999	luey.nawcad.navy.mil
01/Sep/1999	css-gw.ncsc.navy.mil	01/Sep/1999	fw1-5540.itd.nrl.navy.mil
02/Sep/1999	maggiemac.nswc.navy.mil	02/Sep/1999	triton.tycho.ncsc.mil
03/Sep/1999	d157-001.dhcp.nadn.navy.mil	03/Sep/1999	maggiemac.nswc.navy.mil
05/Sep/1999	caballm.npt.nuwc.navy.mil	07/Sep/1999	annex10-u109.itd.nrl.navy.mil
09/Sep/1999	luey.nawcad.navy.mil	10/Sep/1999	gatekeeper.corona.navy.mil
16/Sep/1999	ns2.nadepni.navy.mil	16/Sep/1999	sabre.nosc.mil
17/Sep/1999	krolwp.npt.nuwc.navy.mil	20/Sep/1999	tucker5640.nrl.navy.mil
21/Sep/1999	gw.nnsy.navy.mil	21/Sep/1999	luey.nawcad.navy.mil
22/Sep/1999	cc32c65.navsea.navy.mil	22/Sep/1999	thematrix.ncsc.mil
23/Sep/1999	grooming.ncsc.mil	23/Sep/1999	mail.fttr.navy.mil
23/Sep/1999	proxy.nwc.navy.mil	27/Sep/1999	maggiemac.nswc.navy.mil
27/Sep/1999	ns2.nadepni.navy.mil	27/Sep/1999	putnamd.npt.nuwc.navy.mil
29/Sep/1999	guojiangpc.cs.nps.navy.mil	29/Sep/1999	huey.ntsc.navy.mil
29/Sep/1999	nlschaos.nrl.navy.mil	29/Sep/1999	puppy1.ncsc.mil
01/Oct/1999	maggiemac.nswc.navy.mil	03/Oct/1999	mulan.nrl.navy.mil
05/Oct/1999	kahlua.nosc.mil	06/Oct/1999	chuey.nawcad.navy.mil
06/Oct/1999	sabre.nosc.mil	07/Oct/1999	chuey.nawcad.navy.mil
07/Oct/1999	luey.nawcad.navy.mil	12/Oct/1999	aphrodite.cs.nps.navy.mil
12/Oct/1999	luey.nawcad.navy.mil	13/Oct/1999	thematrix.ncsc.mil
14/Oct/1999	M40582.navo.navy.mil	14/Oct/1999	cxhendrick.med.navy.mil
14/Oct/1999	solita.nosc.mil	16/Oct/1999	pacfa.evepier.navy.mil
19/Oct/1999	hawc-mci.indy.navy.mil	20/Oct/1999	homer.nawcad.navy.mil
20/Oct/1999	lisa.nawcad.navy.mil	20/Oct/1999	maggie.nawcad.navy.mil
20/Oct/1999	norfolk-4.navtap.navy.mil	20/Oct/1999	otto.nawcad.navy.mil
20/Oct/1999	patty.nawcad.navy.mil	21/Oct/1999	mulder2.chinalake.navy.mil
21/Oct/1999	otto.nawcad.navy.mil	21/Oct/1999	patty.nawcad.navy.mil
21/Oct/1999	wiggum.nawcad.navy.mil	22/Oct/1999	cli01.nrl.navy.mil
22/Oct/1999	cnefw.nctsl.navy.mil	22/Oct/1999	hades.ncsc.mil
25/Oct/1999	tenement.nosc.mil	29/Oct/1999	jrw.nrl.navy.mil
01/Nov/1999	homer.nawcad.navy.mil	01/Nov/1999	lisa.nawcad.navy.mil
01/Nov/1999	maggie.nawcad.navy.mil	01/Nov/1999	otto.nawcad.navy.mil
01/Nov/1999	patty.nawcad.navy.mil	01/Nov/1999	selma.nawcad.navy.mil
01/Nov/1999	wiggum.nawcad.navy.mil	02/Nov/1999	m38152.navo.navy.mil
02/Nov/1999	mangw.nsanaples.navy.mil	02/Nov/1999	phoenix.nro.mil
02/Nov/1999	relay6.nima.mil	04/Nov/1999	lincoln.ait.nrl.navy.mil
05/Nov/1999	ag.ncis.navy.mil	05/Nov/1999	m38152.navo.navy.mil
05/Nov/1999	psiwade.nrlssc.navy.mil	08/Nov/1999	roadblock.missi.ncsc.mil
08/Nov/1999	shiloh.ait.nrl.navy.mil	09/Nov/1999	krolwp.npt.nuwc.navy.mil
09/Nov/1999	m38152.navo.navy.mil	09/Nov/1999	vainglory.ncsc.mil
10/Nov/1999	krolwp.npt.nuwc.navy.mil	10/Nov/1999	roadblock.missi.ncsc.mil
10/Nov/1999	triton.cfas.navy.mil	11/Nov/1999	roadblock.missi.ncsc.mil
12/Nov/1999	stahlr-2.navsses.navy.mil	15/Nov/1999	css-gw.ncsc.navy.mil
17/Nov/1999	guojiangpc.cs.nps.navy.mil	18/Nov/1999	printer-john.nosc.mil
18/Nov/1999	titan.phdnswc.navy.mil	22/Nov/1999	munch.nrl.navy.mil
23/Nov/1999	blimp.lakehurst.navy.mil	23/Nov/1999	maddencjw95.dt.navy.mil
24/Nov/1999	poe.nosc.mil	24/Nov/1999	sc033ws112.nosc.mil
26/Nov/1999	roadblock.missi.ncsc.mil	29/Nov/1999	kahlua.nosc.mil
06/Dec/1999	m071728.or.nps.navy.mil	08/Dec/1999	ag.ncis.navy.mil
11/Dec/1999	slc169.cc.nps.navy.mil	14/Dec/1999	mulder2.chinalake.navy.mil
15/Dec/1999	gw.psns.navy.mil	15/Dec/1999	krolwp.npt.nuwc.navy.mil
15/Dec/1999	plattmww95.navsses.navy.mil	16/Dec/1999	enews3.nrl.navy.mil
17/Dec/1999	sc036ws195.nosc.mil	22/Dec/1999	a054-013.crane.navy.mil
22/Dec/1999	mulan.nrl.navy.mil	27/Dec/1999	dcceds33.smartlink.navy.mil
27/Dec/1999	feliujl.npt.nuwc.navy.mil	28/Dec/1999	moses.radium.ncsc.mil
30/Dec/1999	mulder2.chinalake.navy.mil	04/Jan/2000	stinky.nrl.navy.mil

Date	Navy Site	Date	Navy Site
05/Jan/2000	dcceds33.smartlink.navy.mil	05/Jan/2000	dolezal.san.mrms.navy.mil
07/Jan/2000	css-gw.ncsc.navy.mil	11/Jan/2000	nls8.nrl.navy.mil
12/Jan/2000	isar-pc.nrl.navy.mil	12/Jan/2000	m089771.gl.nps.navy.mil
12/Jan/2000	stinky.nrl.navy.mil	13/Jan/2000	gw.psns.navy.mil
19/Jan/2000	lidia.nosc.mil	21/Jan/2000	castellivjw95.dt.navy.mil
21/Jan/2000	slc170.cc.nps.navy.mil	21/Jan/2000	zephir.cs.nps.navy.mil
25/Jan/2000	artaud.cmf.nrl.navy.mil	26/Jan/2000	mulder2.chinalake.navy.mil
27/Jan/2000	moe.ncts.navy.mil	31/Jan/2000	donhqns5.hq.navy.mil
31/Jan/2000	gw.phnsy.navy.mil	01/Feb/2000	buffett.wes.hpc.mil
02/Feb/2000	css-gw.ncsc.navy.mil	02/Feb/2000	curry.nosc.mil
03/Feb/2000	zaku.nrl.navy.mil	05/Feb/2000	lopezh-lt.npt.nuwc.navy.mil
07/Feb/2000	hawc-mci.indy.navy.mil	08/Feb/2000	mulder2.chinalake.navy.mil
08/Feb/2000	nrad-ascend-ppp42.nosc.mil	09/Feb/2000	98.stl.nps.navy.mil
09/Feb/2000	wallaby.nosc.mil	10/Feb/2000	npri8221jl.npt.nuwc.navy.mil
10/Feb/2000	uuv8.npt.nuwc.navy.mil	11/Feb/2000	britterpc.nswc.navy.mil
11/Feb/2000	m089771.gl.nps.navy.mil	11/Feb/2000	npri8221jl.npt.nuwc.navy.mil
14/Feb/2000	bldg80f718.dscr.dla.mil	14/Feb/2000	godzilla.nhtp.med.navy.mil
14/Feb/2000	slc171.cc.nps.navy.mil	16/Feb/2000	rolex.nrl.navy.mil
17/Feb/2000	dc-ceds3-3.smartlink.navy.mil	17/Feb/2000	ns2.nadepni.navy.mil
18/Feb/2000	krolwp.npt.nuwc.navy.mil	22/Feb/2000	donhqns5.hq.navy.mil
22/Feb/2000	relay.nima.mil	23/Feb/2000	denver.cs.nps.navy.mil
23/Feb/2000	gatekeeper.corona.navy.mil	23/Feb/2000	maggiemac.nswc.navy.mil
24/Feb/2000	131-250-18-83.onr.navy.mil	28/Feb/2000	fw1-5540.itd.nrl.navy.mil
02/Mar/2000	homer.nawcad.navy.mil	02/Mar/2000	maggie.nawcad.navy.mil
02/Mar/2000	noca.ecr.navy.mil	02/Mar/2000	otto.nawcad.navy.mil
02/Mar/2000	patty.nawcad.navy.mil	02/Mar/2000	ruggpen.npt.nuwc.navy.mil
02/Mar/2000	selma.nawcad.navy.mil	02/Mar/2000	wiggum.nawcad.navy.mil
03/Mar/2000	ruggpen.npt.nuwc.navy.mil	03/Mar/2000	sandiego-proxy.cnet.navy.mil
06/Mar/2000	gate3.ala.usmc.mil	06/Mar/2000	ns2.jntf.osd.mil
07/Mar/2000	rameses.radium.ncsc.mil	07/Mar/2000	ras2-178.npt.nuwc.navy.mil
07/Mar/2000	sandiego-proxy.cnet.navy.mil	08/Mar/2000	mulan.nrl.navy.mil
09/Mar/2000	homer.nawcad.navy.mil	09/Mar/2000	lisa.nawcad.navy.mil
09/Mar/2000	maggie.nawcad.navy.mil	09/Mar/2000	mulan.nrl.navy.mil
09/Mar/2000	otto.nawcad.navy.mil	09/Mar/2000	patty.nawcad.navy.mil
09/Mar/2000	selma.nawcad.navy.mil	09/Mar/2000	wiggum.nawcad.navy.mil
09/Mar/2000	wsa202.socom.mil	12/Mar/2000	gate2.mfr.usmc.mil
13/Mar/2000	dc-ceds3-2.smartlink.navy.mil	14/Mar/2000	b194-conf1.nosc.mil
14/Mar/2000	m4oohdayaw228.dcmde.dla.mil	15/Mar/2000	awc-raygun.arl.mil
15/Mar/2000	rameses.radium.ncsc.mil	15/Mar/2000	zaku.nrl.navy.mil
16/Mar/2000	gateway-alameda.uscg.mil	16/Mar/2000	mangw.nsanaples.navy.mil
17/Mar/2000	ws23.darpa.mil	20/Mar/2000	a104-111.crane.navy.mil
20/Mar/2000	hades.ncsc.mil	20/Mar/2000	wcs2.norfolk.nipr.mil
21/Mar/2000	gvonkamr.nosc.mil	21/Mar/2000	hawc-mci.indy.navy.mil
21/Mar/2000	madweed8.ncsc.mil	21/Mar/2000	sc036ws137.nosc.mil
22/Mar/2000	m089771.gl.nps.navy.mil	22/Mar/2000	maggiemac.nswc.navy.mil
22/Mar/2000	moses.radium.ncsc.mil	24/Mar/2000	host24.cs.nps.navy.mil
24/Mar/2000	titan.phdnswc.navy.mil	25/Mar/2000	openlab3.physics.nps.navy.mil
28/Mar/2000	gw.phnsy.navy.mil	28/Mar/2000	ingel.nrl.navy.mil
28/Mar/2000	ssminnow.socso.southcom.mil	31/Mar/2000	sequoia.nrl.navy.mil
31/Mar/2000	wcs2.norfolk.nipr.mil	03/Apr/2000	omelet.nosc.mil
03/Apr/2000	penu1271.cnet.navy.mil	03/Apr/2000	wcs2.norfolk.nipr.mil
06/Apr/2000	css-gw.ncsc.navy.mil	06/Apr/2000	gate2.29palms.usmc.mil
06/Apr/2000	wcs2.norfolk.nipr.mil	07/Apr/2000	dc-ceds3-4.smartlink.navy.mil
07/Apr/2000	disacache.ncr.disa.mil	07/Apr/2000	fhu-lap0db5.fhu.disa.mil
07/Apr/2000	m087017.gl.nps.navy.mil	07/Apr/2000	mulder2.chinalake.navy.mil
07/Apr/2000	wcs2.norfolk.nipr.mil	10/Apr/2000	dmzgate2.nadjx.navy.mil
10/Apr/2000	fhu-lap0db5.fhu.disa.mil	11/Apr/2000	dc-ceds3-3.smartlink.navy.mil
11/Apr/2000	disacache.ncr.disa.mil	11/Apr/2000	rpawlakpc.nswc.navy.mil
11/Apr/2000	wcs1.norfolk.nipr.mil	11/Apr/2000	wcs2.norfolk.nipr.mil
11/Apr/2000	wcs3.norfolk.nipr.mil	12/Apr/2000	amsaa-athletics.arl.mil

Date	Navy Site	Date	Navy Site
12/Apr/2000	tuba.nswc.navy.mil	13/Apr/2000	dc-ceds-3.smartlink.navy.mil
13/Apr/2000	wcs2.norfolk.nipr.mil	14/Apr/2000	rangeshelter.ncsc.mil
14/Apr/2000	wcs2.norfolk.nipr.mil	17/Apr/2000	gw-gccs.cpf.navy.mil
17/Apr/2000	wcs2.norfolk.nipr.mil	18/Apr/2000	wcs2.norfolk.nipr.mil
19/Apr/2000	homer.nawcad.navy.mil	19/Apr/2000	lisa.nawcad.navy.mil
19/Apr/2000	maggie.nawcad.navy.mil	19/Apr/2000	otto.nawcad.navy.mil
19/Apr/2000	patty.nawcad.navy.mil	19/Apr/2000	rm-106lcpo.pearl.navy.mil
19/Apr/2000	roadblock.missi.ncsc.mil	19/Apr/2000	uproxy-out.cpf.navy.mil
19/Apr/2000	wiggum.nawcad.navy.mil	20/Apr/2000	m071823.gl.nps.navy.mil
20/Apr/2000	wcs3.norfolk.nipr.mil	21/Apr/2000	ch000757.med.navy.mil
21/Apr/2000	m2b-57.dsmc.dsm.mil	22/Apr/2000	nrad-ascend-ppp74.nosc.mil
24/Apr/2000	css-gw.ncsc.navy.mil	24/Apr/2000	dns25.dfas.mil
24/Apr/2000	gw-gccs.cpf.navy.mil	25/Apr/2000	cedb.nosc.mil
25/Apr/2000	erwing.navsses.navy.mil	25/Apr/2000	hawc-mci.indy.navy.mil
25/Apr/2000	ruggpen.npt.nuwc.navy.mil	25/Apr/2000	uproxy-out.cpf.navy.mil
26/Apr/2000	ghouls.ncsc.mil	09/May/2000	msproxy.transcom.mil
09/May/2000	ns2.jntf.osd.mil	10/May/2000	coruscant.empire.eclipse.ncsc.mil
10/May/2000	ghagapc.nswc.navy.mil	10/May/2000	tjim.arl.mil
11/May/2000	zen.nrl.navy.mil	12/May/2000	birdy.npt.nuwc.navy.mil
12/May/2000	wcs1.norfolk.nipr.mil	13/May/2000	bremnetppp-151.dt.navy.mil
13/May/2000	uproxy-out.cpf.navy.mil	14/May/2000	bremnetppp-151.dt.navy.mil
15/May/2000	css-gw.ncsc.navy.mil	15/May/2000	titan.phdnswc.navy.mil
15/May/2000	uproxy-out.cpf.navy.mil	16/May/2000	gate1.mcbh.usmc.mil
16/May/2000	uproxy-out.cpf.navy.mil	17/May/2000	coffeys.npt.nuwc.navy.mil
17/May/2000	scully2.mugu.navy.mil	17/May/2000	uproxy-out.cpf.navy.mil
17/May/2000	ws185-87.navspecwarcen.navy.mil	18/May/2000	dc-ceds3-3.smartlink.navy.mil
18/May/2000	titan.phdnswc.navy.mil	18/May/2000	uproxy-out.cpf.navy.mil
19/May/2000	dc-ceds3-3.smartlink.navy.mil	19/May/2000	pale.pmrf.navy.mil
19/May/2000	pc139.nhrc.navy.mil	20/May/2000	wcs1.norfolk.nipr.mil
21/May/2000	bremnetppp-151.dt.navy.mil	22/May/2000	gateway3.osd.mil
22/May/2000	wcs1.norfolk.nipr.mil	23/May/2000	bach.nrlssc.navy.mil
23/May/2000	j9-66-74.jfcom.mil	23/May/2000	keek.puget.fisc.navy.mil
23/May/2000	phoenix.nro.mil	24/May/2000	demo.nswc.navy.mil
25/May/2000	dtnet17-25.dt.navy.mil	25/May/2000	gw-gccs.cpf.navy.mil
25/May/2000	khutchison.med.navy.mil	25/May/2000	uproxy-out.cpf.navy.mil
26/May/2000	cicero.nrlssc.navy.mil	26/May/2000	demo.nswc.navy.mil
26/May/2000	sc036ws123.nosc.mil	26/May/2000	wcs1.norfolk.nipr.mil
30/May/2000	gw-gccs.cpf.navy.mil	30/May/2000	polyhedra.nrl.navy.mil
31/May/2000	wcs1.norfolk.nipr.mil	31/May/2000	webcache.kpt.nuwc.navy.mil
01/Jun/2000	relay5.nima.mil	01/Jun/2000	sun5.aic.nrl.navy.mil
02/Jun/2000	singletonqh.efdsouth.navfac.navy.mil	02/Jun/2000	slc174.cc.nps.navy.mil
02/Jun/2000	wcs1.norfolk.nipr.mil	06/Jun/2000	marcie.nosc.mil
06/Jun/2000	webcache.kpt.nuwc.navy.mil	07/Jun/2000	adp-0010.pearl.navy.mil
07/Jun/2000	arena.cs.nps.navy.mil	07/Jun/2000	host12.cs.nps.navy.mil
08/Jun/2000	m42070.navo.navy.mil	08/Jun/2000	ns2.jntf.osd.mil
09/Jun/2000	gate3.lejeune.usmc.mil	09/Jun/2000	jw0.nosc.mil
12/Jun/2000	cnalfw.airlant.navy.mil	12/Jun/2000	gateway-fincen.uscg.mil
12/Jun/2000	oxford.ncsc.mil	12/Jun/2000	pm05.med.navy.mil
13/Jun/2000	cabrallm.npt.nuwc.navy.mil	13/Jun/2000	cnalfw.airlant.navy.mil
13/Jun/2000	demo.nswc.navy.mil	13/Jun/2000	dipernadtw95.dt.navy.mil
14/Jun/2000	b33nt254.nosc.mil	14/Jun/2000	homer.nawcad.navy.mil
14/Jun/2000	maggie.nawcad.navy.mil	14/Jun/2000	patty.nawcad.navy.mil
14/Jun/2000	wiggum.nawcad.navy.mil	16/Jun/2000	baeze.npt.nuwc.navy.mil
16/Jun/2000	ham.alpha.ncsc.mil	20/Jun/2000	beatrix.usno.navy.mil
20/Jun/2000	cleopatra.nosc.mil	21/Jun/2000	maggiemac.nswc.navy.mil
22/Jun/2000	homer.nawcad.navy.mil	22/Jun/2000	maggie.nawcad.navy.mil
22/Jun/2000	manwebproxy.nola.navy.mil	22/Jun/2000	patty.nawcad.navy.mil
22/Jun/2000	richardsonw1mac.dt.navy.mil	22/Jun/2000	wcs1.norfolk.nipr.mil
22/Jun/2000	wiggum.nawcad.navy.mil	23/Jun/2000	dc-ceds3-3.smartlink.navy.mil
23/Jun/2000	patty.nawcad.navy.mil	23/Jun/2000	romel-pc.nosc.mil
23/Jun/2000	s22cx.npt.nuwc.navy.mil	26/Jun/2000	acheron.ncsc.mil

Date	Navy Site	Date	Navy Site
26/Jun/2000	dc-ceds3-3.smartlink.navy.mil	26/Jun/2000	proxy.nwc.navy.mil
27/Jun/2000	dc-ceds3-3.smartlink.navy.mil	27/Jun/2000	fw1-5540.itd.nrl.navy.mil
27/Jun/2000	jib.nrlssc.navy.mil	28/Jun/2000	xeus.nrl.navy.mil
29/Jun/2000	gateway2.osd.mil	29/Jun/2000	polina.arl.mil
30/Jun/2000	bigblue.wes.hpc.mil	03/Jul/2000	aspcmy.arl.mil
04/Jul/2000	wcs1.norfolk.nipr.mil	05/Jul/2000	badger.dsdc.dla.mil
05/Jul/2000	sc106ws077.nosc.mil	06/Jul/2000	a192-214.crane.navy.mil
06/Jul/2000	aspcll3.arl.mil	06/Jul/2000	canis.cs.nps.navy.mil
06/Jul/2000	wsamnsmca7779.sam.pentagon.mil	07/Jul/2000	d118253.dmdc.osd.mil
07/Jul/2000	ren.nrlssc.navy.mil	10/Jul/2000	reds.nosc.mil
12/Jul/2000	dc-ceds3-3.smartlink.navy.mil	12/Jul/2000	relay.nima.mil
12/Jul/2000	scully2.mugu.navy.mil	13/Jul/2000	pc2-2.joaptsc.navy.mil
13/Jul/2000	pc7604-10.nrl.navy.mil	14/Jul/2000	144199.gl.nps.navy.mil
14/Jul/2000	pm05.med.navy.mil	15/Jul/2000	slc174.cc.nps.navy.mil
16/Jul/2000	144207.gl.nps.navy.mil	18/Jul/2000	donovan.arl.mil
19/Jul/2000	host8154.dodmedia.osd.mil	19/Jul/2000	wcs1.norfolk.nipr.mil
21/Jul/2000	sandiego-proxy.cnet.navy.mil	21/Jul/2000	wcs1.norfolk.nipr.mil
23/Jul/2000	144189.gl.nps.navy.mil	24/Jul/2000	dc-ceds3-4.smartlink.navy.mil
25/Jul/2000	heaven.ncsc.mil	25/Jul/2000	ws46-77.pacsw.navy.mil
26/Jul/2000	ytsuc.nosc.mil	27/Jul/2000	homer.nawcad.navy.mil
27/Jul/2000	lisa.nawcad.navy.mil	27/Jul/2000	maggie.nawcad.navy.mil
27/Jul/2000	otto.nawcad.navy.mil	27/Jul/2000	patty.nawcad.navy.mil
27/Jul/2000	wiggum.nawcad.navy.mil	27/Jul/2000	wnsz031.c04xq.spear.navy.mil
28/Jul/2000	dominijannir.npt.nuwc.navy.mil	28/Jul/2000	fhu-se636ba.fhu.disa.mil
28/Jul/2000	homer.nawcad.navy.mil	28/Jul/2000	lisa.nawcad.navy.mil
28/Jul/2000	maggie.nawcad.navy.mil	28/Jul/2000	otto.nawcad.navy.mil
28/Jul/2000	patty.nawcad.navy.mil	28/Jul/2000	wiggum.nawcad.navy.mil
29/Jul/2000	fiopa.fmso.navy.mil	29/Jul/2000	kundera.nrl.navy.mil
30/Jul/2000	unt98.eucom.mil	31/Jul/2000	mulder2.chinalake.navy.mil